

Zero Retries issue 0010 2021-09-17

Advanced Amateur Radio - Data Communications; Space; Microwave... the fun stuff!
Nothing great has ever been accomplished without irrational exuberance. [Tom Eyslin](#).
Irrational exuberance is pretty much the business model of Zero Retries. Steve Stroh N8GNJ
The Universal Purpose of Ham Radio is to have fun messing around with radios. Bob Witte K0NR

Steve Stroh N8GNJ, Editor

Jack Stroh, Late Night Assistant Editor

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This article was initially intended mostly for Zero Retries, with a secondary purpose of informing the [Digital Group of the Mount Baker Amateur Radio Club](#) about the Multipurpose Remote Nodes, as well as a “handout” for development of future Multipurpose Remote Nodes. After the completion of this article for Zero Retries, it seemed more widely applicable than just Whatcom County (as far as I’m aware, the MRNs are unique to Whatcom County) and thus I decided to submit it as a paper for the Proceedings of the [2021 ARRL and TAPR Digital Communications Conference \(DCC\)](#) being held virtually on Friday September 17th and Saturday September 18th 2021.

Multipurpose Remote Nodes

By Steve Stroh N8GNJ and Andy Sayler KF7VOL

Abstract

In [Whatcom County, Washington](#), in the far Northwest corner of the continental US, a group of Amateur Radio operators that are enthusiastic about data communications have created a number of Multipurpose Remote Nodes (MRNs) in key locations within the county for Amateur Radio data communications nodes that can be reconfigured as needed by remote control via Internet.

Most Amateur Radio Operators are familiar with single purpose data communications nodes such as [APRS digipeaters](#) / [IGates](#), or [Winlink Radio Mail Servers \(RMS\)](#), or [fldigi \(fsq\) relay nodes](#). Typically, such nodes are placed in “practical” locations. For example, APRS digipeaters are typically placed on high locations such as mountaintops or towers. APRS IGates are placed in locations that have reliable Internet access. Winlink RMS stations are usually at an individual’s home where a Winlink RMS station will have Internet access.

The Multipurpose Remote Nodes (MRNs) effectively combine all of the above. Because they are multipurpose, and fully remotely configurable (via Internet), they can be placed opportunistically at locations that offer good coverage of a specific area, Internet access, and provide services in a specific area. When the need arises, such as an Winlink RMS is needed in a communications emergency, an MRN can be reconfigured remotely to provide a new service

The MRNs in Whatcom County can also be remotely reconfigured to different frequencies either in the 2 meter band (144-148 MHz) or the 70 centimeter (440-450 MHz) band.

Brief History of Development

The beginning of the Multipurpose Remote Nodes was to build a fill-in APRS digipeater / IGate to be co-located with a UHF repeater at a [fire station located on a high ridge in Ferndale, Washington](#). Andy Sayler KF7VOL was an active user of APRS and had noticed that Ferndale was not covered very well by existing APRS digipeaters in Whatcom County. In planning for an APRS digipeater / IGate at the fire station, physical access would have to be arranged in advance, so the “Ferndale digi” had to be designed for remote access via Internet rather than physical access. The co-located UHF repeater already had Internet access, so that was a good fit for a co-located APRS IGate.

Around the same time that KF7VOL got the Ferndale digi online, two other Whatcom County Amateur Radio Operators - Budd Churchward WB7FHC and Steve Magnuson AG7GN were working together to develop hardware and software for what is now the [Nexus DR-X “Digital Radio Cross-patch”](#). The Nexus DR-X is a multipurpose data communications unit that is based on a Raspberry Pi, a sound card for the Raspberry Pi, and a closely matched and well maintained “image” of Raspberry Pi operating system and applications, [specifically built and tested for the Nexus DR-X](#). WB7FHC and AG7GN were aided in the development of the Nexus DR-X by an enthusiastic group of testers and users that were members of the [Mount Baker Amateur Radio Club’s Digital Group](#) (MBARC DG) in Whatcom County, Washington.

KF7VOL realized that using the Nexus DR-X solved two key issues he had identified in his planning for other low-level data communications nodes that he hoped to deploy at other host facilities in Whatcom County. Using the Nexus DR-X made it possible:

- To have remote access to, and management of the system on a par with physical access. The Raspberry Pi is a fully functional Linux computer, which included a robust remote access system called VNC (Virtual Network Computing), that included full remote access to the Raspberry Pi desktop environment, making it possible to (fully remotely) change software applications as needed, as well as perform nearly any function on the Raspberry Pi just as if you were working at a keyboard, mouse, and display that were connected directly to the Raspberry Pi

- Use stable, mature, well-tested applications for an APRS digipeater / IGate, a Winlink RMS, and the fldigi suite of applications, including fsq. Changing the function of the node was a simply a matter of loading different software (remotely).

An additional capability in the Nexus DR-X was an application called [flrig](#) which can remotely control the settings of certain radios such as the [Kenwood TM-V71A](#). flrig enabled remote control of the radio's frequency (including changing bands between 144-148 MHz and 440-450 MHz) and other operating parameters.

With the Nexus DR-X, a remote node could be built with standardized components to provide three (or more) different services - APRS digipeater / IGate, Winlink RMS, or as a relay node for fsq simplex text chat (which is widely used in Whatcom County). KF7VOL's "fill-in digipeater" had evolved into a Multipurpose Remote Node.

Unobtrusive Electronic Cabinets in Unobtrusive Locations



Photo courtesy of Andy Saylor KF7VOL (The Ethernet switch is not part of the MRN.)



Photo courtesy of Andy Saylor KF7VOL

To “fit in, unobtrusively” at additional host facilities in Whatcom County, KF7VOL decided to build the MRNs in a “6U” cabinet that could be mounted on a wall in an unobtrusive area such as a utility closet or other “out of the way” area. The key “selling points” of the MRNs were:

- No floor space or desk space or “conditioned space” was required from the host facility, only some wall space in an out of the way area.
- Because the MRNs could be operated fully remotely, physical access to the MRN is rarely required.
- When reaching out to potential new host facilities, KF7VOL leveraged his membership in Whatcom Emergency Communications Group (WECG) which is well-regarded in Whatcom County.
- In approaching additional host facilities, KF7VOL used a soft-sell, take-it-slow, answer-any-questions approach was used. It helped greatly that the original MRN in Ferndale was operational and had proven out the reliability of the system.



Photo courtesy of Andy Sayler KF7VOL



Photo courtesy of Andy Sayler KF7VOL

Components of a Multipurpose Remote Node

A typical MRN consists of the following hardware:

- Dual band omnidirectional antenna plus feed line to the MRN rack
- 11-inch (6U) wall-mount cabinet with a shelf and a plexiglas front cover with a key lock
- Power supply - 12 volts @ 20 amps (typical) - silver unit on left side
- Uninterruptible power supply (AC in, AC out) - bottom of cabinet

- Nexus DR-X Digital Cross-patch unit - upper right corner
- Kenwood TM-V71A 144-148 / 440-450 MHz radio - top, middle
- Internet controllable remote power switch, capable of switching on / off two electrical circuits. This unit allows for a “power off reset” in case the radio or Raspberry Pi locks up and cannot be remotely managed. Bottom, middle
- Fuse / distribution block (12 volt circuits) - lower right corner
- Non-managed Ethernet switch - bottom of cabinet
- “Data” cable (6-pin MiniDIN) between the Nexus DR-X and the radio - beige cable
- “Programming” cable between the Nexus DR-X and the radio - black cable

External connections required for an MRN are:

- Coaxial cable to 144-148 / 440-450 MHz dual band omnidirectional antenna (typical),
- 120 VAC power,
- Ethernet / “external” Internet access with at least one static IPv4 IP address

Provisions are made for the possibility that physical, local access / operation of the MRN might be required by including the microphone for the radio within the cabinet (though it’s not normally connected) and a front panel port provides access to a USB port and HDMI port for the Raspberry Pi.

Active MRNs in Whatcom County

The MRN concept has proven to be reliable, usable, and scalable. There are now six MRNs in Whatcom County, Washington:

- Acme, WA fire station Winlink RMS on 144.93 MHz (K7SFV-10)
- Bellingham, WA Bellingham Technical College Winlink RMS on 144.99 MHz (KB7TEC-10)
- Bellingham, WA Western Washington University APRS digipeater / IGate on 144.39 MHz (N7WWU)
- Bellingham, WA Whatcom County Search and Rescue building Winlink RMS on 144.93 MHz (W7ECG-10)
- Ferndale, WA fire station APRS digipeater / IGate on 144.39 MHz (W7JIM)
- Lynden, WA private home Winlink RMS on 144.91 (KF7VOL-10)

The result of these MRNs are that Whatcom County, WA now has excellent county-wide coverage for APRS, has a number of Winlink RMS nodes accessible from most areas of Whatcom County, and several nodes that can act as fsq relay stations. And, of course, all this functionality can be reconfigured remotely as circumstances and emergencies dictate.

Possible MRN Improvements

Future features being considered for the MRNs:

- Replacing the problematic AC to AC uninterruptible power supply with a DC to DC uninterruptible power supply
- Adding remote voice capability via a second Raspberry Pi unit with an audio interface connected to the radio’s microphone input, speaker output, and microphone push-to-talk (PTT) circuit.
- Adding a low-power AREDN node operating on 2.3 GHz to each MRN.
- Identifying suitable radios that can be remotely controlled as the Kenwood TM-V71A is apparently out of production.
- Because the services being provided on the MRNs operate solely on 144-148 MHz, there is potential to replace the current dual band radio with a 144-148 MHz radio and a 440-450 MHz radio that can operate simultaneously for uses such as remote repeater inputs, high-speed data communications, etc. There’s even the possibility of replacing existing antennas with tri-band antennas and adding a third radio for use on 222-225 MHz.

Future MRNs in Whatcom County

Future MRNs in Whatcom County (and surrounding areas) will be projects of, and sponsored by the Mount Baker Amateur Radio Club’s Digital Group.

A future MRN is being planned for nearby Lookout Mountain. This MRN will use a remotely controllable HF / 144-148 MHz radio. Potentially, this MRN could offer a remotely controlled HF station, but that will require more research and planning. Another change being made on this MRN is that to provide higher reliability, the Raspberry Pi will boot from and use a solid state disk (SSD) connected to a USB port, rather than the more usual SD card for booting and operating.

MRN Lessons Learned

Lessons Learned in deploying MRNs in Whatcom County, WA:

- Sell the benefits of Amateur Radio emergency communications and explain why it’s being requested to install a system at their facility.

- Have at least informal backing of a local organization such as an Amateur Radio club or EMCOR group.
- Explain that there are only modest facilities requirement such as wall space in a utility area, basic power, and a route to the roof for coax, and most antenna installation.
- If the host facility requires that antenna installation can only be done by the facility's personnel or a contractor, do not push back against that requirement - find a way to pay for those services.
- Do not request any funds or anything from the host facility - only "wall space", antenna installation, power, and Internet access.
- Engage early with the host facility's Information Technology (IT) group about the requirement for Internet access and a static IP address. Don't "surprise them" at the last moment - allow sufficient time for IT planning and processes.
- Provide full point of contact information for an individual (preferably more than one) "in case there are problems". This is especially true for the IT department supplying the Internet access and static IP address.
- Provide an easy way to turn off the unit locally (shutdown switch) "in case there are problems".
- Maintain regular contact with the host facility's personnel so they'll feel comfortable contacting you first "in case there are problems", rather than just yanking the power plug or the Ethernet cable.
- Add signage to the front of the cabinet to explain at a glance what this unfamiliar electronics unit (not owned by the facility) actually does, such as "Amateur Radio Emergency Communications System" with point of contact info (again, preferably more than one point of contact), a copy of the Amateur Radio license for the unit, etc.
- Provide the key for the front panel lock to a local facilitator in case you have a cooperative person onsite who can power cycle the unit, check cable connections, etc.

Our thanks to Budd Churchward WB7FHC for contributing background information for this article and his ongoing support for the Multipurpose Remote Node project. Our thanks to Steve Magnuson AG7GN for incorporating changes to the Nexus DR-X software image that make it easier to manage the Whatcom County MRNs.

Our thanks to Whatcom Emergency Communications Group for their sponsorship of the Whatcom County Multipurpose Remote Nodes project.

Some Organizations and Tools That Could Help Create New Paradigm Network Amateur Radios

This is the conclusion of the New Paradigm Network Amateur Radio Series in Zero Retries 0007, Zero Retries 0008, and Zero Retries 0009.

Funding

- **Amateur Radio Digital Communications (ARDC)**

In mentioning that [Amateur Radio Digital Communications \(ARDC\) provides grants \(funding\) for "Interesting Ideas in Amateur Radio"](#), I must disclaim that I'm a 2021 volunteer member of the ARDC Grants Advisory Committee, and that I do not represent ARDC, or speak for ARDC about what they will and will not provide grants for. If one of these ideas makes it to the stage of a grant request to ARDC, I'll have to recuse myself from that particular grant review.

I am saying that if any of the preceding ideas resonate with and you are equipped to act on those (or other) "Interesting Ideas in Amateur Radio" - there *may* be funding available through ARDC to make your idea a reality.

- **Open Research Institute**

I won't attempt to characterize Open Research Institute (ORI) other than to note that they state "[YOUR PROJECT IS WELCOME](#)" (their capitalization, not my shouting). There is a relationship between ARDC and ORI that, again, I won't attempt to characterize other than to note that ORI can work with entities that ARDC cannot work with directly at the moment. For example, [ORI is working with M17 Project, using funding from ARDC](#).

Publishing

- **Publish in the Open... Somewhere**

I get that there is a reflexive tendency for US Amateur Radio Operators to publicize an interesting project by submitting it to ARRL for publication in their publications QST (general audience) or QEX (technical audience). Respectfully... please don't. Doing so relegates your hard work behind a very opaque paywall that renders it invisible to anyone but the 20% of US Amateur Radio Operators who are currently members of the ARRL. *Thus publishing your hard work via the ARRL will be invisible to 80% of US Amateur Radio Operators, and nearly 100% of those who aren't Amateur Radio Operators.*

- One free, default place to publish is Github. Yes, you *can* [publish just a paper](#) on Github.
- Another suggestion is to publish your paper via the annual [ARRL and TAPR Digital Communications Conference \(DCC\)](#). It will get a lot of attention there from some very sharp minds in Amateur Radio. Caution - TAPR has sometimes not published submitted papers in electronic form, so keep a copy for publication elsewhere just in case. But guaranteed, publishing via the DCC will get attention, thus it's worth the hassle.
- Another venue for publishing a paper is TAPR's quarterly newsletter, the [Packet Status Register \(PSR\)](#). They've periodically made noise about restricting distribution of PSR to only paid TAPR members, but to date, they've kept access to PSR in the open.
- Although [Hackaday.io](#) is, technically, an operation of a for-profit company, it's remarkably accessible for open source projects. It proclaims itself as "... the world's largest collaborative hardware development community." Most notably, it's the primary repository for information on [New Packet Radio](#).
- Whatever method you decide to use for publishing your hard work, please frequently snapshot it by saving it often using the Internet Archive's Wayback Machine ["Save Page Now" feature](#). Doing so insures that your work is preserved for posterity when the website inevitably goes away.

FCC Permissions for Experimentation

If you're not comfortable with the "Asking for forgiveness rather than asking for permission" paradigm of pioneering new radio technology, there are more formal approaches.

- **Special Temporary Authority**

It's little known in Amateur Radio, but there is precedent about pioneering new modes of operation that aren't (currently) within the strict scope of the FCC regulations using a provision in the FCC rules called [Special Temporary Authority \(STA\)](#). The application for an STA seems straightforward, if a bit daunting for a typical Amateur Radio Operator. As discussed above, if applying for an STA seems too daunting, and not having an STA seems a significant roadblock to development, perhaps ARDC or ORI could provide assistance - financial, or otherwise. It doesn't hurt to ask.

- **Experimental License - Part 5**

See below for a good use of an FCC Experimental License. My sense is (without intensive study of the FCC rules) is that an Experimental License is open-ended, longer term, whereas a STA is more limited for shorter periods. My sense is that a successful STA could lead to an Experimental License.

Crowdfunding, Building, Distributing, and Customer Support of Hardware

- [Crowd Supply](#) is one of my favorite vendors of [interesting radio devices](#). In addition to operating crowdfunding campaigns (similar to Kickstarter), Crowd Supply can assist in sourcing, assembling, stocking, and distributing devices. Crowd Supply has already proven itself in several radio devices such as [LimeSDR Mini](#), [LimeRFE](#), and an interesting upcoming device, [CaribouLite RPi Hat](#).
- [Tindie](#) is another vendor of [interesting wireless devices](#), but they seem to be mostly a front end. Tindie has also proven itself in several radio devices such as [HamShield LoRa Edition](#), [New Packet Radio Modem](#), and [70cm Power Amplifier \(PA\) for New Packet Radio](#). Having purchased from Tindie, it seems like hardware creators have to be the back end for production, fulfillment, and support.

A Long, Imperfect Specification for RAMA

In Zero Retries 0006, I offered a Brief, Imperfect Specification for RAMA (an open source project to create an equivalent to VARA FM). I've now written a *Long, Imperfect Specification for RAMA* which I'll discuss it in depth in a future issue of Zero Retries. Before then, if you'd like access to it, just email me.

Request To Send

For those techies that get the joke, welcome to the *eleventh* issue of Zero Retries, not the second.

As I write this, I have material queued up for at least five more issues of Zero Retries. I've come to embrace Substack's email length limits as quite sensible. That said, sometimes it's a bit of a puzzle to fit in various articles around those limitations. For example, I would have preferred the "Some Organizations and Tools" article to have appeared in Zero Retries 0009, but it was full-to-burstin'.

As I compose this issue in early September, because of various unforeseen commitments, I've spent far more time in the preceding six months *away* from N8GNJ Labs than in it. (Fortunately, writing Zero Retries is a "Have *Laptop*, Will *Travel*" endeavor.) It now requires a lot less time to create an issue of Zero Retries than it used to. Thus I have a bit more time, and physical presence now in my office, for two new priorities in the months ahead.

The first is that I'm going to address some lingering infrastructure issues with Zero Retries, such as rehosting Zero Retries onto [zeroretires.org](#). That won't happen immediately, but soon... enough. I'm also going to work on a better feedback / discussion system than the comments on Zero Retries' page on Substack and a consolidation system for discussions that (confusingly) span multiple issues of Zero Retries. That will be a website of some kind - TBD.

My second priority is to get a lot more hands-on time on radios and other hardware here at N8GNJ Labs. First up is (promised - I haven't forgotten Jeff) experiments with [fldigi flamp](#). That will be followed quickly by getting some across-the-shop VARA FM stations online for experimentation. And, since they so unwisely elected me as their new President, there is also a [Digital Group here in Whatcom County](#) to lead into interesting new experiments and experiences in the coming year. Please wish them (and me) well with that.

Closing The Channel

As of 2021-09-13, Zero Retries is now on Twitter - [@zeroretires](#). I'm not yet *very* active there, but I'll try to pay attention.

A commenter in Reddit pointed out that I should disclaim that the views I express in about Amateur Radio in Zero Retries are mostly about Amateur Radio in the US. That comment is correct, thus consider it disclaimed that Zero Retries has a US-centric perspective of Amateur Radio. I do my best to think of "rest of world" Amateur Radio in my writing, but I'm not there in other parts of the world, so if I say something blatantly inaccurate, please call me out.

If you're enjoying Zero Retries, please tell your friends and co-conspirators. For the immediate future, Zero Retries will remain an experiment in progress. Feedback is easy if you're reading Zero Retries in email - just hit Reply and I'll get your email. Or you can go to the web version of any Zero Retries issue, scroll to the bottom, and post a comment on the web version of a Zero Retries issue. I'm especially interested in content ideas about things that you'd like to see discussed in Zero Retries. If you know of "Zero Retries Interesting" projects, groups, activities, etc. please let me know. I do reply to every Zero Retries email I receive.

Email issues of Zero Retries are "instrumented" by [Substack](#) to gather basic statistics about opens, clicking links, etc. There is no "text only, no instrumentation" version of Zero Retries available. I don't use such information in any way other than (in the absence of much feedback) getting some satisfaction that the data shows that people actually do read Zero Retries.

All previous issues of Zero Retries are available without restriction (no paywalls). For some background on Zero Retries, Issue 0000 was The Introduction Issue.

Thanks for reading!
Steve Stroh N8GNJ
Bellingham, Washington, USA
2021-09-17

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Below is a much more complete "footer" that has evolved over 30+ issues of ZR.

Join the *Fun* on Amateur Radio

If you're not yet licensed as an Amateur Radio Operator, and would like to join the fun by *literally having a license to experiment with radio technology*, here are some pointers:

- **Ham Radio for Dummies** by Ward Silver N0AX is a great overview of Amateur Radio. N0AX is a gifted writer and HRFD is now in its [4th edition](#).
- My two favorite **YouTube** channels for a good overview of Amateur Radio are [AmateurLogic.TV](#) and [Ham Nation](#) (part of Ham Radio Crash Course). These folks just seem to have so much fun!
- [Radio Amateur Training Planning and Activities Committee \(RATPAC\)](#) offers weekly presentations on general Amateur Radio topics (Wednesdays) and emergency communications in Amateur Radio (Thursdays).
- Dan Romanchik KB6NU offers a free **No-Nonsense Study Guide** for the [Technician test](#) (PDF).
- [HamExam.org Amateur Radio Practice Exams](#) offers good **Flash Card and Practice Exams**.
- When you're ready to take an **Amateur Radio examination** (Tech, General, or Extra), W1MX - The MIT Amateur Radio Society offers [remote exams](#), free for students and youngsters. *There are apparently [many other remote exam options](#).*

Bonus - with an Amateur Radio license, you'll be [more attractive on dates](#) 😊

Closing the Channel

- In its mission to grow Amateur Radio and make it more relevant to society in the 2020s and beyond, Zero Retries is published via email and web, and is available to anyone at no cost. Zero Retries is proud *not to participate* in the Amateur Radio Publishing Industrial Complex!
- My ongoing Thanks to Tina Stroh KD7WSF for, well, *everything* and Bill Vodall W7NWP as *Zero Retries Instigator in Chief*.
- My ongoing Thanks to pseudostaffers [Dan Romanchik KB6NU](#) and [Jeff Davis KE9V](#) for continuing to spot, and write about "Zero Retries Interesting" type items, on their respective blogs, from Amateur Radio and beyond, that I don't spot on my own.
- [Southgate Amateur Radio News](#) consistently surfaces "Zero Retries Interesting" stories.
- The [Substack email publishing platform](#) makes Zero Retries possible. I recommend it for publishing newsletters.

If you see something interesting mentioned in Zero Retries and would like to search all the Zero Retries "Back Issues", that's now easy - just click:

Search Zero Retries

If you're reading this issue on the web and you'd like to see Zero Retries in your email Inbox every Friday afternoon, just click:

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Leave a comment

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More bits from Steve Stroh N8GNJ:

- [SuperPacket blog](#) - *Discussing new generations of Amateur Radio Data Communications - beyond Packet Radio (a precursor to Zero Retries)*
- [N8GNJ blog](#) - *Amateur Radio Station N8GNJ and the mad science experiments at N8GNJ Labs - Bellingham, Washington, USA*

Thanks for reading!

Steve Stroh N8GNJ (He / Him)

These bits were handcrafted in beautiful Bellingham, Washington, USA

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